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# (54) Scroll type fluid displacement apparatus with an axial seal plate

Spiralanlage zur Fluidverdrängung mit Scheibe zur axialen Dichtung

Appareil de déplacement des fluides à spirales avec plaque d'étanchéité axiale

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## Description

Field of the Invention

**[0001]** The invention relates to a scroll type fluid displacement apparatus, and more particularly, to an axial seal plate for the scrolls used in a scroll type fluid compressor.

Description of the Prior Art

**[0002]** Scroll type fluid displacement apparatuses are known in the prior art. For example, U.S. Patent No. 801,182 issued to Creux discloses a basic construction of a scroll type fluid displacement apparatus including two scroll members, each having an end plate and a spiroidal or involute spiral element extending from the end plates. The scrolls are maintained angularly and radially offset so that both spiral elements interfit to form a plurality of line contacts between their spiral curved surfaces to thereby seal off and define at least one pair of fluid pockets. The relative orbital motion of the two scrolls shirts the line contact along the spiral curved surfaces and, as a result, changes the volume in the fluid pockets. The volume of the fluid pockets increases or decreases depending on the direction of orbital motion. Thus, a scroll type fluid displacement apparatus is applicable to compress, expand or pump fluids.

**[0003]** In comparison with conventional piston type compressors, scroll type compressors have certain advantages, such as fewer parts and continuous compression of fluid. However, one of the problems with scroll type compressors is the difficulty in sealing the fluid pockets. Axial and radial sealing of the fluid pockets must be maintained in a scroll type compressor in order to achieve efficient operation. The fluid pockets are defined by line contacts between the interfitting spiral elements and the axial contacts between the axial end surface of one spiral element and the inner end surface of the facing plate.

**[0004]** With reference to Figures 1 and 2, one prior art sealing mechanism is shown, and includes an involute seal plate 51 made of steel having slit 151 therein. Involute seal plate 51 is disposed on an end surface of the end plate of at least one of scrolls 27 (28). Slit 151 is formed on spiral element 272 of scroll 27. Involute seal plate 51 faces the axial end surface of the spiral element of the other scroll. A gap G of constant width is formed between the radial end of the involute seal plate and the radial end of the spiral element and extends from the beginning end to the terminal end of the spiral elements.

**[0005]** The interfitting spiral elements, normally constructed of lightweight alloys, such as aluminum alloy, are subject to several temperature zones which are caused by the increasing pressure and decreasing volume as the fluid moves to the center of the compressor. The greatest temperature exists in the center of the compressor, as this pocket has the smallest volume and the largest pressure. This causes greater thermal expansion at the center of the spiral element than at any other portion. Since the thermal expansion coefficient of aluminum alloy is generally greater than that of steel, the aluminum will be affected more by temperature changes than steel. As the center of the spiral element expands thermally, the center of the involute seal plate is subjected to higher stresses then the outer radial portions. As a result, the center of the spiral element is subject to damage and failure.

**[0006]** Furthermore, from GB 2 167 133 A a scroll type fluid displacement apparatus is known having the features of the preamble of claim 1. Like in the above-mentioned subject a gap of constant width is formed between the radial end of the involute seal plate and the radial end of the spiral element.

**[0007]** It is an object of the present invention to provide a scroll type fluid displacement apparatus with an axial sealing plate which prevents abnormal wear and damage to the scrolls.

**[0008]** This object is solved by a scroll type fluid displacement apparatus as set forth in claim 1.

**[0009]** Preferred developments of the invention are given in the subclaims.

**[0010]** Further objects, features and other aspects of this invention will be understood from the following detailed description of the preferred embodiments of this invention with reference to the annexed drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

**[0011]** Figure 1 is a front view of a scroll of a scroll type refrigerant compressor in accordance with the prior art

**[0012]** Figure 2 is a front view of an involute plate member of a scroll type refrigerant compressor in accordance with the prior art.

**[0013]** Figure 3 is a vertical longitudinal sectional view of a scroll type refrigerant compressor in accordance with one embodiment of the present invention.

**[0014]** Figure 4 is a diagram illustrating the properties of an involute of a circle.

**[0015]** Figure 5 is a diagram of two involutes illustrating the basic properties of an involute wrap of a scroll.

**[0016]** Figure 6 is an enlarged partial view of a part of a spiral element of a scroll compressor illustrating the configuration of an involute plate member in accordance with a first embodiment of the present invention.

**[0017]** Figure 7 is an enlarged partial view of a part of a spiral element of a scroll compressor illustrating the configuration of an involute plate member in accordance with a second embodiment of the present invention.

**[0018]** Figure 8 is an enlarged partial view of a part of a spiral element of a scroll compressor illustrating the configuration of an involute plate member in accordance with a third embodiment of the present invention.

**[0019]** Figure 9 is an enlarged partial view of a part of a spiral element of a scroll compressor illustrating the configuration of an involute plate member in accordance with a fourth embodiment of the present invention.

**[0020]** Figure 10 is an enlarged partial view of a part of a spiral element of a scroll compressor illustrating the configuration of an involute plate member in accordance with a fifth embodiment of the present invention.

**[0021]** Figure 11 is an enlarged partial sectional view taken along line 11-11 of Figure 10.

## DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

**[0022]** Referring to Figure 3, a fluid displacement apparatus in accordance with the present invention is shown in the form of scroll type refrigerant compressor unit 100. Compressor unit 100 includes compressor housing 10 having front end plate 11 mounted on cup-shaped casing 12.

**[0023]** An opening 111 is formed in center of front end plate 11 for penetration of drive shaft 13. An annular projection 112 is formed in the rear end surface of front end plate 11. Annular projection 112 faces cup-shaped casing 12 and is concentric with opening 111. An outer peripheral surface of annular projection 112 extends into an inner wall of the opening of cup-shaped casing 12 so that the opening of cup-shaped casing 12 is covered by front end plate 11. An O-ring 14 is placed between the outer peripheral surface of annular projection 112 and the inner wall of the opening of cup-shaped casing 12 to seal the mating surface of front end plate 11 and cup-shaped casing 12.

**[0024]** An annular sleeve 15 projects from the front end surface of front end plate 11 to surround drive shaft 13. Annular sleeve 15 defines a shaft seal cavity. In the embodiment shown in Figure 3, sleeve 15 is formed separately from front end plate 11. Therefore, sleeve 15 is fixed to-the front end surface of front end plate 11 by screws (not shown). An O-ring 16 is placed between the end surface of front end plate 11 and an end surface of sleeve 15. Alternatively, sleeve 15 may be formed integrally with front end plate 11.

**[0025]** Drive shaft 13 is rotatably supported by sleeve 15 through bearing 18, which is located within the front end of sleeve 15. Drive shaft 13 has disk 19 at its inner end. Disk 19 is rotatably supported by front end plate 11 through bearing 20 located within opening 111 of front end plate 11. A shaft seal assembly 21 is coupled to drive shaft 13 within the shaft seal cavity of sleeve 15.

**[0026]** A pulley 22 is rotatably supported by bearing 23, which is carried on the outer surface of sleeve 15. An electromagnetic coil 24 is fixed about the outer surface of sleeve 15 by support plate 25, and is disposed within the annular cavity of pulley 22. An armature plate 26 is elastically supported on the outer end of drive shaft 13. Pulley 22, magnetic coil 24 and armature plate 26 form a magnetic clutch. In operation, drive shaft 13 is driven by an external drive power source, for example, the engine of an automobile, through a rotation transmitting device, such as a magnetic clutch.

**[0027]** A number of elements are located within the inner chamber of cup-shaped casing 12, including a fixed scroll 27, an orbiting scroll 28, a driving mechanism for orbiting scroll 28 and a rotation preventing/thrust bearing device 35 for orbiting scroll 28. The inner chamber of cup-shaped casing 12 is formed between the inner wall of cup-shaped casing 12 and the rear end surface of front end plate 11.

**[0028]** Fixed scroll 27 includes circular end plate 271, a wrap or spiral element 272 affixed to or extending from one side surface of circular end plate 271, and internally threaded bosses 273 axially projecting from the other end surface of circular plate 271. An axial end surface of each boss 273 is seated on the inner surface of bottom plate portion 121 of cup-shaped casing 12 and fixed by screws 37 screwed into bosses 273. Thus, fixed scroll 27 is fixed within the inner chamber of cup-shaped casing 12. Circular plate 271 of fixed scroll 27 partitions the inner chamber of cup-shaped casing 12 into a front chamber 29 and rear chamber 30. A seal ring 31 is disposed within a circumferential groove of circular end plate 271 to form a seal between the inner wall of cup-shaped casing 12 and the outer surface of circular end plate 271. Spiral element 272 of fixed scroll 27 is located within front chamber 29.

**[0029]** Cup-shaped casing 12 is provided with a fluid inlet port 36 and fluid outlet port 39, which are connected to front and rear chambers 29 and 30, respectively. A discharge port 274 is formed through circular plate 271 near the center of spiral element 272. A reed valve 38 closes discharge port 274.

**[0030]** Orbiting scroll 28, which is located in front chamber 29, includes a circular end plate 281 and a wrap or spiral element 282 affixed to or extending from one side surface of circular end plate 281. Spiral elements 272 and 282 interfit at an angular offset of 180 degrees and a predetermined radial offset. Spiral elements 272 and 282 define at least one pair of sealed off fluid pockets between their interfitting surfaces. Orbiting scroll 28 is rotatably supported by bushing 33 through bearing 34 placed between the outer peripheral surface of bushing 33 and the inner surface of annular boss 283 axially projecting from the end surface of circular end plate 281 of orbiting scroll 28. Bushing 33 is connected to an inner end of disk 19 at a point radially offset or eccentric with respect to drive shaft 13.

**[0031]** Rotation preventing/thrust bearing device 35 is disposed between the inner end surface of front end plate 11 and the end surface of circular end plate 281. Rotation preventing/thrust bearing device 35 includes fixed ring 351 attached to the inner end surface of front end plate 11, orbiting ring 352 attached to the end surface of circular end plate 281, and a plurality of bearing elements, such as balls 353, placed between the pockets formed by rings 351 and 352. The axial thrust load from orbiting scroll 28 also is supported on front end plate 11 through balls 353.

**[0032]** Spiral elements 272 and 282 include grooves 275 and 285 on the axial end surfaces thereof. Seal element 40 is disposed in the grooves to the mating surfaces seal against each circular end plate 271 and 281. Involute plate 41, which is formed of a hard metal, such as hardened steel, is fitted to the end surface of both end plates 271 and 281 to minimize the abrasion and reduce the wear of the scrolls.

**[0033]** Generally, the side wall of the spiral element of a scroll follows an involute of a circle such as Figure 4. This involute is formed by beginning at starting point P of the generating circle A and tracing the involute from the end of an extensible string unwinding from point P. The curvature of the involute, i.e., the length L along a tangent from generating circle A to the intersection of the involute, is given by $L = \theta \cdot r$, where $\theta$ is the involute angle, and r is the radius of generating circle A. Figure 5 illustrates two involutes, one involute, I, starts at point P on the generating circle A, and the other involute, II, start at point Q on generating circle A. Point Q is located at angular offset of $\phi$ from point P. Since length M along the tangent from generating circle A to the intersection of involute I is given by $M = \theta \bullet r$, and length L along the tangent from generating circle A to the intersection of involute II is given by $L=(\theta-\phi)\bullet r$, the distance D between both involutes I and II is given by $M-L = \theta\bullet r - (\theta-\phi)\bullet r = \phi\bullet r$. Thus, the distance between involutes I and II is uniform and is not influenced by the involute angle at which the distance is measured. Further, the beginning wall of the spiral element of scroll includes a curve, III, which is substantially streamline-shaped and links point Q with point R so as to be convex toward center O of generating circle A. Point R lies on the involute in the vicinity of point P, but not exactly on point P.

**[0034]** Referring to Figure 6, involute plate 41 includes slit 141 which has inner edge 142, outer edge 143 and extreme line 144 linking inner edge 142 with outer edge 143. Slit 141 is shaped similar to the side walls of spiral elements 272 (282) in order to insert plate 41 over spiral elements 272 (282). Slit 141 is designed to be broader in width than spiral elements 272 (282). Gaps G1 are created between inner edge 142 and inside wall 272a of spiral element 272 (282), and between outer edge 143 and outside wall 272b of spiral element 272 (282). Inner edge 142 and outer edge 143 include first involute portions 142a and 143a towards the center thereof and second involutes 142b and 143b towards the outer ends thereof, respectively.

**[0035]** First involute portion 142a of inner edge 142 is formed by beginning at starting point Pi of a generating circle A and tracing the involute from the end of an extensible string unwinding from point Pi. The curvature of the involute, i.e., the length L along a tangent from generating circle A to the intersection of first involute portion 142a, is given by $L = (\theta-\alpha)\bullet r$, where $\alpha$ is the design phase angle similar to the configuration of spiral element 272. First involute portion 142a joins second involute portion 142b at point $P_2$ where length L of first involute 142a is equal to $L_1$, given by $L_1= (3\pi/2-\alpha)\cdot r$. At any point on first involute 142a length L is smaller than $L_2$, $L_2 = 2\pi r$ (when first involute 142a is formed with one turn). Second involute portion 142b begins at point $P_2$, tracing the involute from the end of an extensible string unwinding from point $P_3$ and continuing to the end of involute plate 41. Point $P_3$ is located at angular offset of $(\alpha-\beta)$ from point $P_1$. Length M along the tangent from generating circle A to the intersection of second involute 142b is given by $M = (\theta-\beta)\cdot r$. Distance D between both involutes 142a and 142b is given by $M-L = (\theta-\beta)\cdot r-(\theta-\alpha)\cdot r=(\alpha-\beta)\cdot r$ = a constant.

**[0036]** Similarly, first involute portion 143a of outer edge 143 begins at starting point $Q_4$ from the end of an extensible string unwinding from point $Q_1$ of generating circle A. The curvature of the involute, i.e., a length N along a tangent from generating circle A to the intersection of first involute 143a, is given by $N = (\theta+\alpha)\cdot r$, where $\alpha$ is the design phase angle. First involute portion 143a joins second involute 143b at point $Q_2$ Second involute portion 143b is formed by beginning at $Q_3$ and tracing the involute from the end of an extensible string unwinding from point $Q_3$ of generating circle A and continuing to the end of involute plate 41. Point $Q_3$ is located at angular offset of $(\alpha-\beta)$ from point $Q_1$. Length S along the tangent from the generating circle to the intersection of second involute 143b is given by $S = (\theta+\beta)\bullet r$. Distance K between both involutes 143a and 143b is given by $N-S = (\theta+\alpha)\cdot r-(\theta+\beta)\cdot r = (\alpha-\beta)\cdot r$ = a constant

**[0037]** Extreme line 144 of slit 141 of involute plate 41 is preferably a streamline-shaped curve, which is similar in shape to the beginning of end wall 272c of spiral element 272 (282). Extreme line 144 links point $P_1$ with point $Q_4$ and is convex toward center O of generating circle A. Point $Q_4$ lies on first involute 143a in the vicinity of point $Q_1$.

**[0038]** Gap $G_1$ is created between the inner edge 142 at the first involute portion 142a and the inside wall 272a of spiral element 272, between the outer edge 143 at the first involute portion 143a and the outside wall 272b of spiral element 272, and between extreme line 144 and the beginning of the end wall 272c of the spiral element 272 (282). Gap $G_0$ is created between second involute portion 142b of inner edge 142 and inside wall 272a of spiral element 272, and between second involute portion 143b of outer edge 143 and outside wall 272b of spiral element 272. Gap $G_1$ is greater than gap $G_0$ by D (or K) = $(\alpha-\beta) \bullet r$ = a constant

**[0039]** In the above arrangement of scroll type refrigerant compressor, fluid from the external fluid circuit is introduced into fluid pockets in the compressor unit through inlet port 36. As orbiting scroll 282 orbits, the fluid in the fluid pockets moves to the center of the spiral elements and is compressed. The compressed fluid is discharged into rear chamber 30 through discharge hole 274. The compressed fluid then is discharged to the external fluid circuit through outlet port 39.

**[0040]** First involute portion 142a of inner edge 142 and first involute portion 143a of outer edge 143 of involute plate 41 are sized to avoid contact with the beginning of the end wall 272c of spiral element 272 (282) even if the beginning of the end wall 272c thermally expands.

**[0041]** As a result, the beginning of the end wall 272c of spiral element 272 (282) is better protected against damage or fatigue failure.

**[0042]** Referring to Figure 7, a second embodiment of the present invention is shown which is directed to a modified configuration of involute plate 41. This involute plate is similar to involute plate 41 described above. However, some differences do exist as follows.

**[0043]** Involute plate 41 includes slit 241 which has inner edge 242, outer edge 243 and extreme line 244 linking inner edge 242 with outer edge 243. Inner edge 242 begins at point $P_3$ of circle A and is formed by tracing the involute from the end of an extensible string unwinding from point $P_3$. The curvature of the involute, i.e., a length L along a tangent from generating circle A to the intersection of inner edge 242, is given by $L = (\theta-\beta) \cdot r$, where $\beta$ is the design phase angle. The description of outer edge 243 is omitted because it is substantially identical to the first embodiment.

**[0044]** Extreme line 244 of slit 241 preferably has a streamline-shaped curve, which is similar in shape to the beginning of the end wall 272c of spiral element 272 (282). Extreme line 244 links point $P_3$ with point $Q_4$ toward center 0 of generating circle A. Point $Q_4$ lies on first involute portion 243a towards the center thereof in the vicinity of point $Q_1$.

**[0045]** Gap $G_1$ is created between first involute portion 243a of outer edge 243 and outside wall 272b of spiral element 272. Gap $G_0$ is created between inner edge 242 and inside wall 272a of spiral element 272. Gap $G_2$ is created between extreme line 244 and the beginning of the end wall 272c of spiral element 272 (282). The size of gap $G_2$ changes to $G_1$ at $Q_4$ and to $G_0$ at $P_3$. Gap $G_1$ is larger than gap $G_2$ by D (or K) = $(\alpha-\beta)\bullet r$ = a constant.

**[0046]** Substantially the same advantages are realized in the first and second preferred embodiments, so details of the advantages are not repeated.

**[0047]** Referring to Figure 8, a third embodiment of the present invention is shown which is directed to a modified configuration of involute plate 41. This involute plate is similar to involute plate 41 described above. However, some differences do exist as follows.

**[0048]** Involute plate 41 includes slit 341 which has inner edge 342, outer edge 343 and extreme line 344 linking inner edge 342 with outer edge 343. The description of inner edge 342 is omitted, since it is substantially identical to that of the first embodiment. Outer edge 343 begins at point $Q_5$ and is formed by tracing the involute from the end of an extensible string unwinding from point $Q_3$ on circle A. Point $Q_5$ is defined by the point at which length T is tangent to outer edge 343. Line T is perpendicular to line $L_1$. The curvature of the involute, i.e., length N along a tangent from generating circle A to the intersection of outer edge 343, is given by $N = (\theta-\beta)\cdot r$. where $\beta$ is the design phase angle. Further, extreme line 344 of slit 341 is preferably a streamline-shaped curve, which is similar in shape to the beginning of the end wall 272c of spiral element 272 (282). Extreme line 344 includes first line 344a linking point $P_1$ with point $Q_4$ and second line 344b linking point $Q_4$ with $Q_5$. Point $Q_4$ lies on first involute portion 342a towards the center thereof in the vicinity of point $Q_1$.

**[0049]** Gap $G_1$ is created between the first involute portion 342a and inside wall 272a of spiral element 272 and between first line 344a of extreme line 344 and the beginning of the end wall 272c. Gap $G_0$ is created between second involute portion 342b towards the outer ends thereof and inside wall 272a of spiral element 272. Gap $G_3$ is created between second line 344b of extreme line 344 and the beginning of the end wall 272c of spiral element 272 (282). The size of gap $G_3$ changes to $G_1$ at $Q_4$ and to $G_0$ at $Q_5$. Gap $G_1$ is larger than gap $G_0$ by D (or K) = $(\alpha-\beta)\bullet r$ = a constant

**[0050]** Substantially the same effects and advantages as those in the first embodiment are realized, so the details are not repeated.

**[0051]** Referring to Figure 9, a fourth embodiment of the present invention is shown which is directed to a modified configuration of involute plate 41. This involute plate is similar to involute plate 41 described above. However, some differences do exist as follows.

**[0052]** Extreme line 444 links point $P_1$ with point $Q_5$ and is convex toward center O of generating circle A. Point $Q_5$ is defined by the point where line T is tangent to first involute portion 443a towards the center thereof of outer edge 443. Line T is perpendicular to length $L_1$.

**[0053]** Gap $G_4$ is created between extreme line 444 and the beginning of the end wall 272c of spiral element 272 (282). Gap $G_4$ is larger than $G_1$.

**[0054]** Substantially the same effects and advantages as those in the first embodiment can be obtained. In addition, in the fourth embodiment, involute plate 41 rotates in the direction of arrow. Scroll 28 temporally rotates together with involute plate 41, when the compressor is started. Extreme line 444 of slit 441 does not contact the edge portion of beginning of the end wall 272c. However, second involute portion 442b and 443b towards the outer ends thereof contact the inside wall 272a or outside wall 272b. As a result, first involute portion 442a or first involute portion 443a are prevented from striking inside wall 272a, outside wall 272b, or the beginning of the end wall 272c, even if caused by the rotation of involute plate 41.

**[0055]** Referring to Figures 10 and 11, a fifth embodiment of the present invention is shown which is directed to a modified configuration of involute plate 41. This involute plate is similar to involute plate 41 described above. However, some differences do exist as follows.

**[0056]** Involute plate 41 includes slit 541 which has inner edge 542, outer edge 543 and extreme line 544 linking inner edge 542 with outer edge 543. Gap $G_0$ is created between inner edge 542 and inside wall 272a of spiral element 272, between outer edge 543 and outside wall 272b of spiral element 272, and between extreme line 544 and beginning of the end wall of spiral element 272.

**[0057]** In the production of involute plate 41, slit 541 is formed by punching. This production process naturally produces beveled curved portions 544 and 545 and C-cut portions 546 and 547.

**[0058]** Therefore, even if beginning of the end wall 272c of spiral element 272 has greater thermal expansion than the other portions of spiral element 272 and interfits with inner edge 542, outer edge 543, or extreme line 544, inner edge 542, outer edge 543, and extreme line 544 do not interfere with beginning of the end wall 272c of spiral element 272. As a result, the beginning of the end wall 272c of spiral element 272 (282) is abetter protected against damage and fatigue failure.

## Claims

**1.** A scroll type fluid displacement apparatus comprising:

a pair of scrolls (27, 28), each said scroll having a circular end plate (271, 281) and a spiral element (272, 282) extending from an axial end surface of said circular end plate (271, 281), said pair of scrolls (27, 28) maintained at an angular and radial offset to make a plurality of line contacts which define a plurality of defined fluid pockets;

a driving mechanism operatingly connected to one of said scrolls (28) to effect relative orbital motion with respect to the other of said scrolls (27) to thereby change the volume of said fluid pockets;

an involute plate (41) including an involute slit (141, 241, 341, 441, 541) formed therein, said spiral elements (272, 282) inserted into said involute slit, said involute plate (41) being disposed on an axial end surface of said circular end plate (271, 281) of both of said scrolls (27, 28) to cover the area on which contact is made by an axial end surface of an opposite spiral element, said involute slit including an inner edge (142, 242, 342, 442, 542), an outer edge (143, 243, 343, 443, 543) and a center edge (144, 244, 344, 444, 544) joining said inner edge with said outer edge,

characterized in

that a first gap (G1, G2, G3, G4) formed between said center edge and center convex end wall (272C) as well as between inner and outer edge and inside and outside walls (272a, 272b) along a portion towards the center of said spiral element (272, 282) is greater than a second gap (G0) formed between said inner and outer edges and said spiral element walls towards the outer end of said spiral element (272, 282).

**2.** The scroll type fluid displacement apparatus recited in claim 1, wherein

said inner edge and said outer edge respectively include first portions (142a, 143a, 243a, 342a, 442a, 443a) extending from said center edge and second portions (142b, 143b, 243b, 342b, 442b, 443b) extending from said first portions,

a first gap (G1) is formed between said first portions of said inner and outer edges of said involute slit and inside and outside wall (272a, 272b) of said spiral element (272, 282), which is different than a gap (G2, G3, G4) formed between said center edge of said involute slit and a center convex wall (272C) of said spiral elements, both of these gaps being larger than said second gap (G0) formed between said second portions of said inner and outer edges of said involute slit and the walls of said spiral element (272, 282).

**3.** The scroll type fluid displacement apparatus recited in claim 1 or 2, wherein said involute slit has a shape similar to the sidewalls of said spiral element (272, 282).

**4.** The scroll type fluid displacement apparatus recited in claim 2, wherein each of said first portions of said inner edge and outer edge is respectively formed by tracing an involute of a generating circle with an end of an extensible string, said first portions of said inner edge and outer edge joining said second portions where length $L_1$ along a tangent from said generating circle to an intersection with said first portion, is $L_1 = 2\pi \cdot r$, where r is a radius of said generating circle.

**5.** The scroll type fluid displacement apparatus recited in one of claims 1 to 5, wherein

said involute slid (54) includes a beveled surface (544, 545) formed on at least one edge thereof.

**6.** The scroll type fluid displacement apparatus recited in one of claims 1 to 5, wherein said involute slit (541) includes a beveled surface formed on at least one corner thereof.

**7.** The scroll type fluid displacement apparatus recited in one of claims 2 to 5, wherein a beveled surface of said involute slit (541) is formed on said first portion of said inner and/or outer edges, said second portion of said inner and/or outer edge and/or said center edge of said involute slit (541).

8. The scroll type fluid displacement apparatus recited in one of claims 1 to 5, wherein a beveled surface of said involute slit (541) is located near an axial end of said circular end plate (271, 281) of said scrolls (27, 28).

9. The scroll type fluid displacement apparatus recited in one of claims 1 to 5, wherein a beveled surface of said involute slit (541) is formed in the vicinity of a center of said involute slit (541).

**Patentansprüche**

1. Spiralfluidverdrängungsgerät mit:

einem Paar von Spiralen (27, 28), wobei jede Spirale eine kreisförmige Endplatte (271, 281) und ein Spiralelement (272, 282) aufweist, das sich von einer axialen Endoberfläche der kreisförmigen Endplatte (271, 281) erstreckt, wobei das Paar von Spiralen (27, 28) mit einer winkelmäßigen und radialen Versetzung zum Herstellen einer Mehrzahl von Linienkontakten gehalten werden, die eine Mehrzahl von abgegrenzten Fluidtaschen definieren;
einem Antriebsmechanismus der betriebsmäßig mit einer der Spiralen (28) verbunden ist zum Bewirken einer relativen umlaufenden Bewegung in Bezug auf die andere der Spiralen (27) zum dadurch Ändern des Volumens der Fluidtaschen;
einer Involutenplatte (41), die einen darin gebildeten Involutenschlitz (141, 241, 341, 441, 541) enthält, wobei die Spiralelemente (272, 282) in den Involutenschlitz eingeführt sind, die Involutenplatte (41) auf einer axialen Endoberfläche der kreisförmigen Endplatte (271, 281) von beiden der Spiralen (27, 28) vorgesehen ist zum Bedecken der Fläche, auf der der Kontakt gebildet wird mit einer axialen Endoberfläche eines gegenüberliegenden Spiralelementes, der Involutenschlitz eine Innenkante (142, 242, 342, 442, 542), eine Außenkante (143, 243, 343, 443, 543) und eine Zentralkante (144, 244, 344, 444, 544), die die Innenkante mit der Außenkante verbindet, aufweist;

**dadurch gekennzeichnet,**
**daß** eine erste Lücke (G1, G2, G3, G4), die zwischen der Zentralkante und einer zentralen konvexen Endwand (272C) als auch zwischen der Innen- und Außenkante und der Innenseiten- und Außenseitenwand (272a, 272b) entlang eines Abschnittes zu dem Zentrum des Spiralelementes (272, 282) gebildet ist, größer als eine zweite Lücke (G0) ist, die zwischen der Innen- und Außenkante und den Spiralelementwänden zu dem äußeren Ende des Spiralelementes (272, 282) gebildet ist.

2. Spiralfluidverdrängungsgerät nach Anspruch 1, bei dem
die Innenkante und die Außenkante entsprechend erster Abschnitte (242a, 143a, 243a, 342a, 442a, 443a), die sich von der Zentralkante erstrecken, und zweite Abschnitte (142b, 143b, 243b, 342b, 442b, 443b), die sich von den ersten Abschnitten erstrecken, aufweisen, eine erste Lücke (G1) zwischen den ersten Abschnitten der Innen- und der Außenkanten des Involutenschlitzes und der Innenseiten- und Außenseitenwand (272a, 272b) des Spiralelementes (272, 282) gebildet ist, die sich von einer Lücke (G2, G3, G4) unterscheidet, die zwischen der Zentralkante des Involutenschlitzes und einer konvexen Zentralwand (272c) der Spiralelemente gebildet ist, wobei beide diese Lücken größer als die zweite Lücke (G0) sind, die zwischen den zweiten Abschnitten der Innen- und der Außenkanten des Involutenschlitzes und der Wände des Spiralelementes (272, 282) gebildet ist.

3. Spiralfluidverdrängungsgerät nach Anspruch 1 oder 2, bei dem der Involutenschlitz eine Form ähnlich zu den Seitenwänden des Spiralelementes (272, 282) aufweist.

4. Spiralfluidverdrängungsgerät nach Anspruch 2, bei dem jeder der ersten Abschnitte der Innenkante und der Außenkante entsprechend durch Folgen einer Involuten mit einem Ende eines ausdehnbaren Fadens gebildet wird, wobei die ersten Abschnitte der Innenkante und der Außenkante mit den zweiten Abschnitten dort verbunden sind, wo die Länge $L_1$ entlang einer Tangente von dem Erzeugerkreis zu einem Schnittpunkt mit dem ersten Abschnitt $L_1=2\pi \cdot r$ beträgt, wobei r ein Radius des Erzeugerkreises ist.

5. Spiralfluidverdrängungsgerät nach einem der Ansprüche 1 bis 4,
bei dem der Involutenschlitz (54) eine angeschrägte Oberfläche (544, 545) aufweist, die an mindestens einer Kante davon gebildet ist.

6. Spiralfluidverdrängungsgerät nach einem der Ansprüche 1 bis 5, bei dem der Involutenschlitz (541) eine angeschrägte Oberfläche aufweist, die an mindestens einer Ecke davon gebildet ist.

7. Spiralfluidverdrängungsgerät nach einem der Ansprüche 2 bis 5, bei dem eine angeschrägte Oberfläche des Involutenschlitzes (541) auf dem ersten Abschnitt der Innen- und/oder Außenkanten, dem

zweiten Abschnitt der Innen- und/oder Außenkante und/oder der Zentralkante des Involutenschlitzes (541) gebildet ist.

**8.** Spiralfluidverdrängungsgerät nach einem der Ansprüche 1 bis 5, bei dem eine angeschrägte Oberfläche des Involutenschlitzes (541) nahe einem axialen Ende der kreisförmigen Endplatte (271, 281) der Spiralen (27, 28) angeordnet ist.

**9.** Spiralfluidverdrängungsgerät nach einem der Ansprüche 1 bis 5, bei dem eine angeschrägte Oberfläche des Involutenschlitzes (541) in der Nähe eines Zentrums des Involutenschlitzes (541) gebildet ist.

## Revendications

**1.** Appareil de déplacement de fluide du type à spirales comprenant :

> une paire de spirales (27, 28) comportant chacune une plaque d'extrémité circulaire (271, 281) et un élément en spirale (272, 282) s'étendant à partir d'une face d'extrémité axiale de ladite plaque d'extrémité circulaire (271, 281), ladite paire de spirales (27, 28) étant maintenue avec un décalage angulaire et radial de manière à réaliser une pluralité de contacts linéaires définissant une pluralité de poches de fluide ;
> un mécanisme d'entraînement (22, 24, 13) raccordé fonctionnellement à l'une desdites spirales (28) pour effectuer un mouvement orbital relatif par rapport à l'autre desdites spirales (27) de manière à modifier ainsi le volume desdites poches de fluide ;
> une plaque de développement (41) comportant une fente de développement (141 ; 241 ; 341 ; 441 ; 541) formée dans celle-ci, lesdits éléments en spirale (272, 282) étant insérés dans ladite fente de développement, ladite plaque de développement (41) étant disposée sur une face d'extrémité axiale de ladite plaque d'extrémité circulaire (271, 281) desdites deux spirales (27, 28) pour recouvrir la surface sur laquelle le contact est réalisé par une surface d'extrémité axiale d'un élément en spirale opposé, ladite fente de développement comportant un bord interne (142 ; 242 ; 342 ; 442 ; 542), un bord externe (143 ; 243 ; 343 ; 443 ; 543) et un bord central (144 ; 244 ; 344 ; 444 ; 544) reliant ledit bord interne audit bord externe,

**caractérisé en ce qu'**un premier espace (G1, G2, G3, G4) formé entre ledit bord central et ladite paroi d'extrémité convexe centrale (272c) ainsi qu'entre le bord interne et externe et les parois intérieure et extérieure (272a, 272b) le long d'une partie tournée vers le centre dudit élément en spirale (272, 282) est supérieur à un deuxième espace (G0) formé entre lesdits bords interne et externe et lesdites parois d'élément en spirale vers l'extrémité externe dudit élément en spirale (272, 282).

**2.** Appareil de déplacement de fluide du type à spirales selon la revendication 1, dans lequel

> ledit bord interne et ledit bord externe comportent respectivement des premières parties (142a, 143a ; 243a, 342a ; 442a, 443a) s'étendant depuis ledit bord central et des deuxièmes parties (142b, 143b ; 243b, 342b ; 442b, 443b) s'étendant depuis lesdites premières parties,
> un premier intervalle (G1) est formé entre lesdites premières parties desdits bords interne et externe de ladite fente de développement et la paroi intérieure et extérieure (272a, 272b) dudit élément en spirale (272, 282), différent d'un intervalle (G2, G3, G4) formé entre ledit bord central de ladite fente de développement et une paroi convexe centrale (272c) desdits éléments en spirale, ces deux intervalles étant plus grands que ledit deuxième intervalle (G0) formé entre lesdites deuxièmes parties desdits bords interne et externe de ladite fente de développement et les parois dudit élément en spirale (272, 282).

**3.** Appareil de déplacement de fluide du type à spirales selon la revendication 1 ou 2, dans lequel ladite fente de développement a une forme similaire aux parois latérales dudit élément en spirale (272, 282).

**4.** Appareil de déplacement de fluide du type à spirales selon la revendication 2, dans lequel chacune desdites premières parties desdits bord interne et bord externe est respectivement formée en traçant un développement d'un cercle générateur avec une extrémité d'une chaîne extensible, lesdites premières parties desdits bord interne et bord externe réunissant lesdites deuxièmes parties où la longueur $L_1$ le long d'une tangente depuis ledit cercle générateur jusqu'à une intersection avec ladite première partie, est $L_1 = 2\pi \cdot r$, où r est le rayon dudit cercle générateur.

**5.** Appareil de déplacement de fluide du type à spirales selon l'une des revendications 1 à 5, dans lequel ladite fente de développement (54) comporte une surface biseautée (544, 545) formée sur au moins l'un de ses bords.

**6.** Appareil de déplacement de fluide du type à spirales selon l'une des revendications 1 à 5, dans lequel ladite fente de développement (541) comporte une surface biseautée formée sur au moins l'un de ses coins.

**7.** Appareil de déplacement de fluide du type à spirales selon l'une des revendications 2 à 5, dans lequel une surface biseautée de ladite fente de développement (541) est formée sur ladite première partie desdits bords interne et/ou externe, ladite deuxième partie dudit bord interne et/ou externe et/ou ledit bord central de ladite fente de développement (541).

**8.** Appareil de déplacement de fluide du type à spirales selon l'une des revendications 1 à 5, dans lequel une surface biseautée de ladite fente de développement (541) est située près d'une extrémité axiale de ladite plaque d'extrémité circulaire (271, 281) desdites spirales (27, 28).

**9.** Appareil de déplacement de fluide du type à spirales selon l'une des revendications 1 à 5, dans lequel une surface biseautée de ladite fente de développement (541) est formée au voisinage du centre de ladite fente de développement (541).

FIG. 1
(Prior Art)

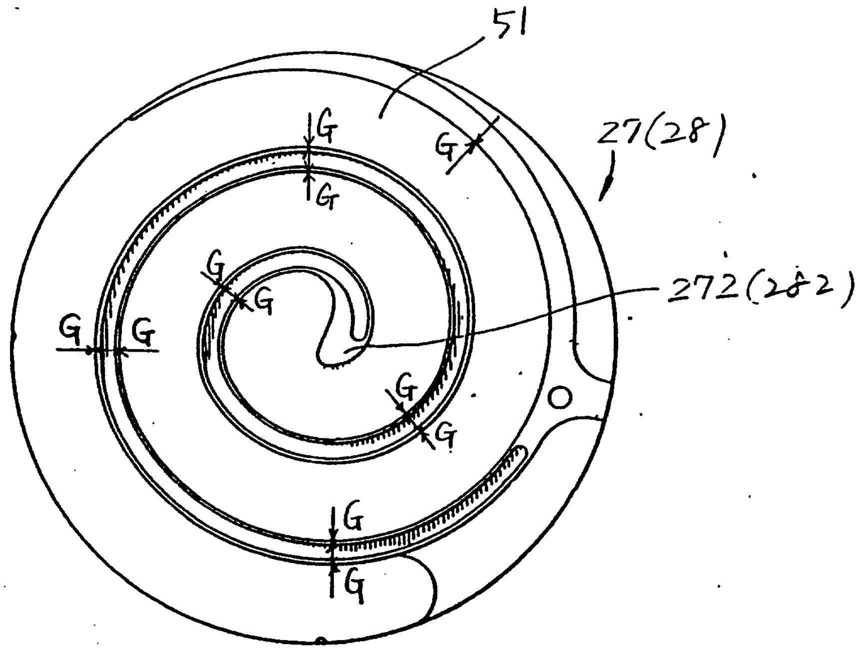
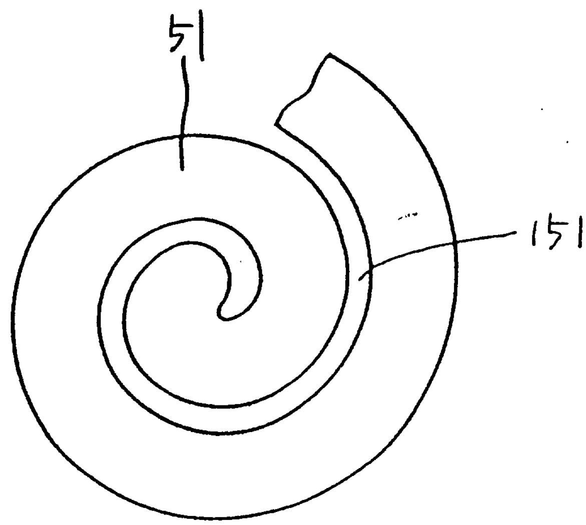



FIG. 2
(Prior Art)



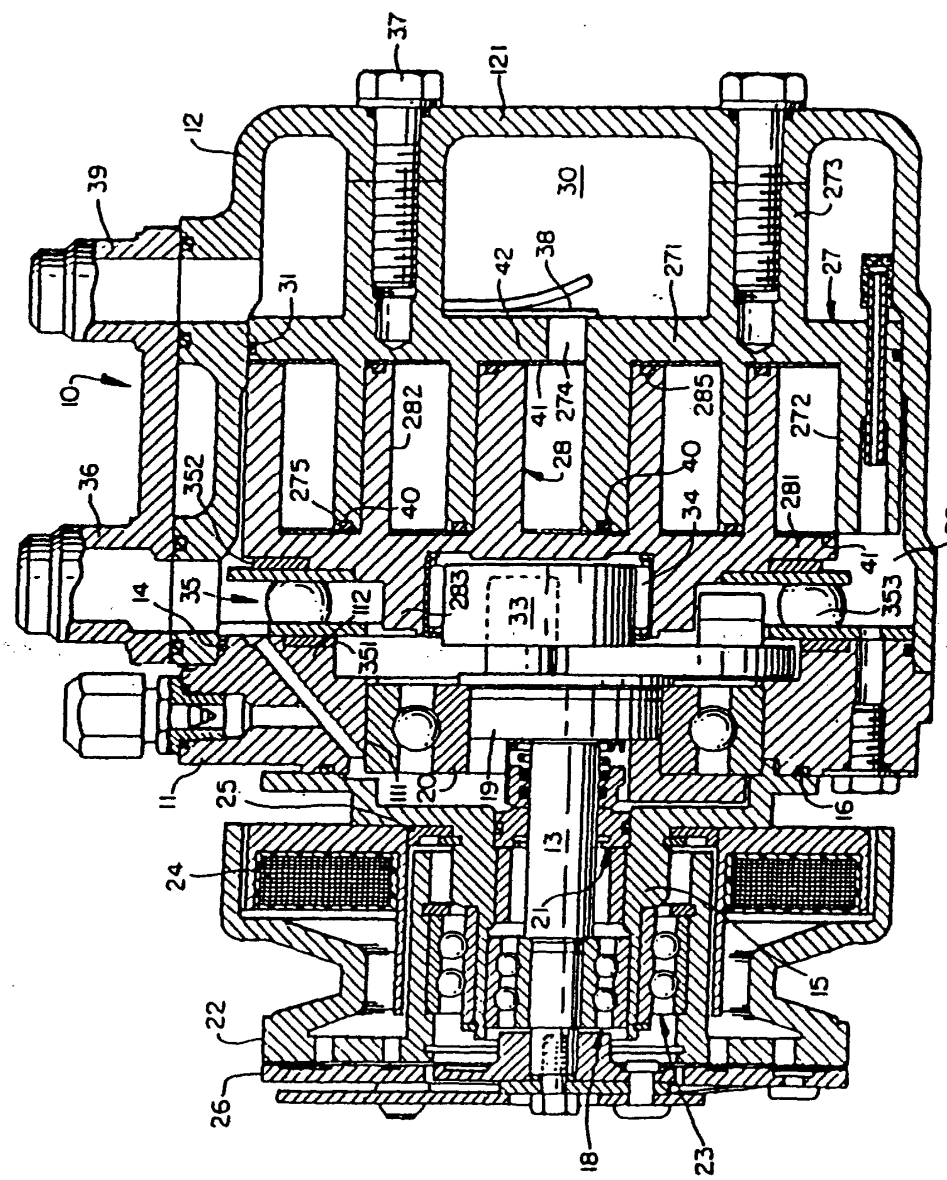

37
121
12
39
30
42
38
31
273
271
27
10
282
41
274
285
28
272
352
275
40
36
34
281
29
35
14
283
112
33
353
351
111
20
19
16
11
25
24
13
21
15
22
26
18
23

FIG 3

FIG 4

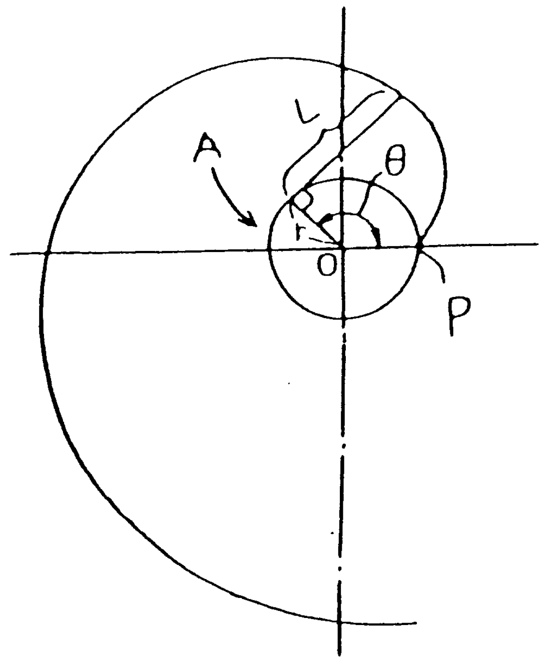



FIG. 5

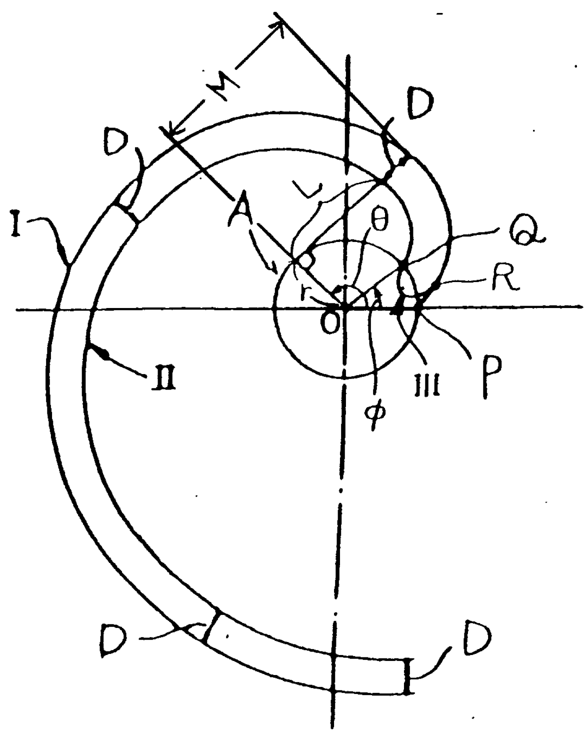


FIG.6

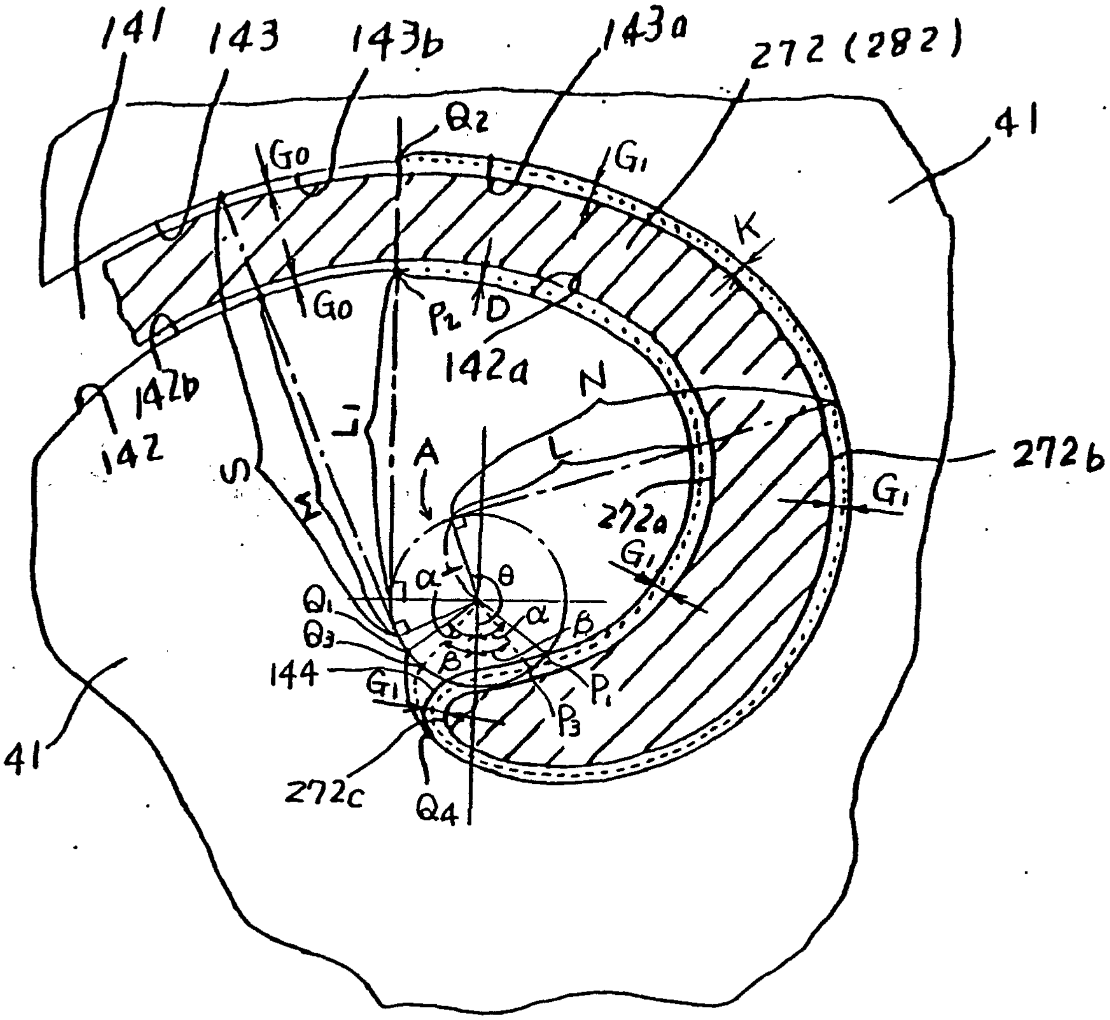

141
143
143b
143a
272 (282)
41
Q2
Go
G1
K
Go
P2
D
142b
142a
N
142
L
272b
S
A
G1
272a
G1
Q1
θ3
α
θ
α
β
144
β
P1
G1
P3
41
272c
Q4

FIG. 7

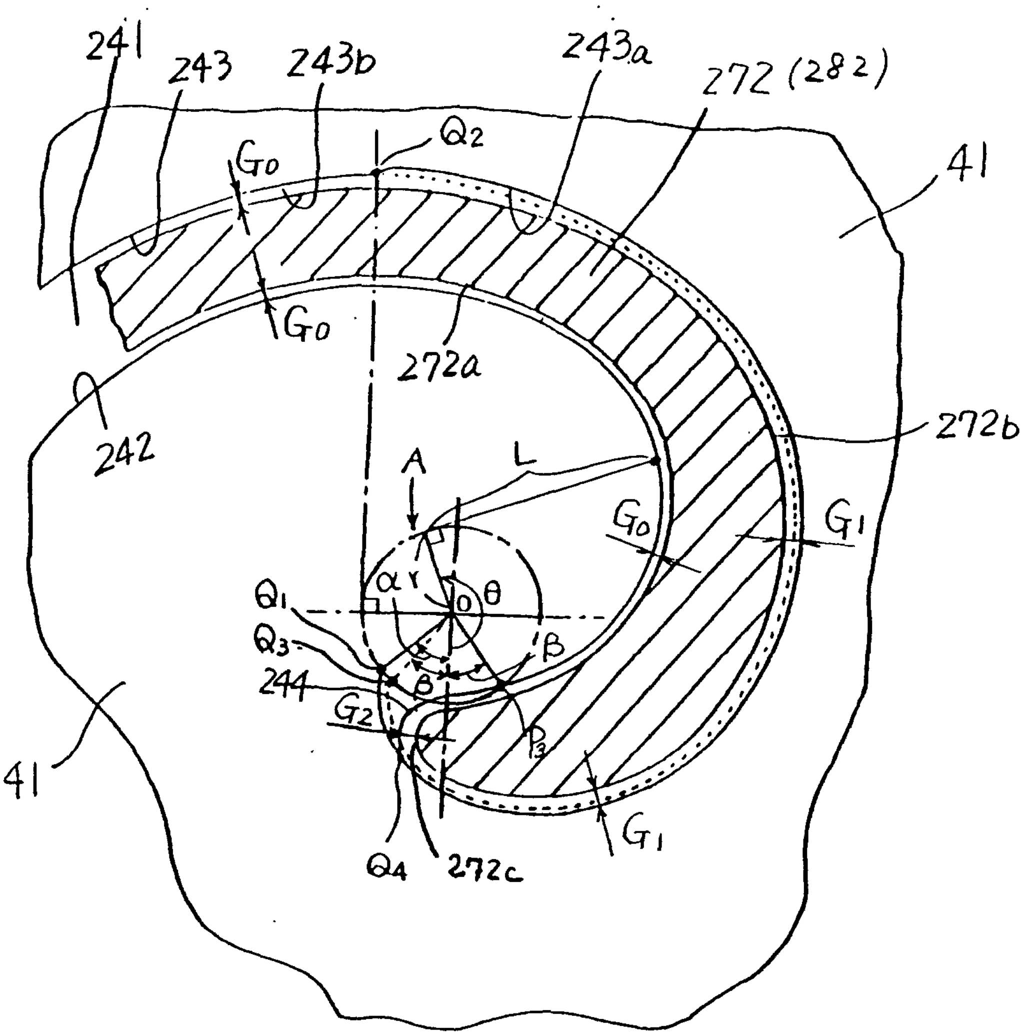

241
243
243b
243a
272 (282)
41
Q2
G0
G0
272a
272b
242
A
L
G0
G1
Q1
α
γ
O
θ
Q3
β
244
β
G2
P3
41
G1
Q4
272c

FIG. 8

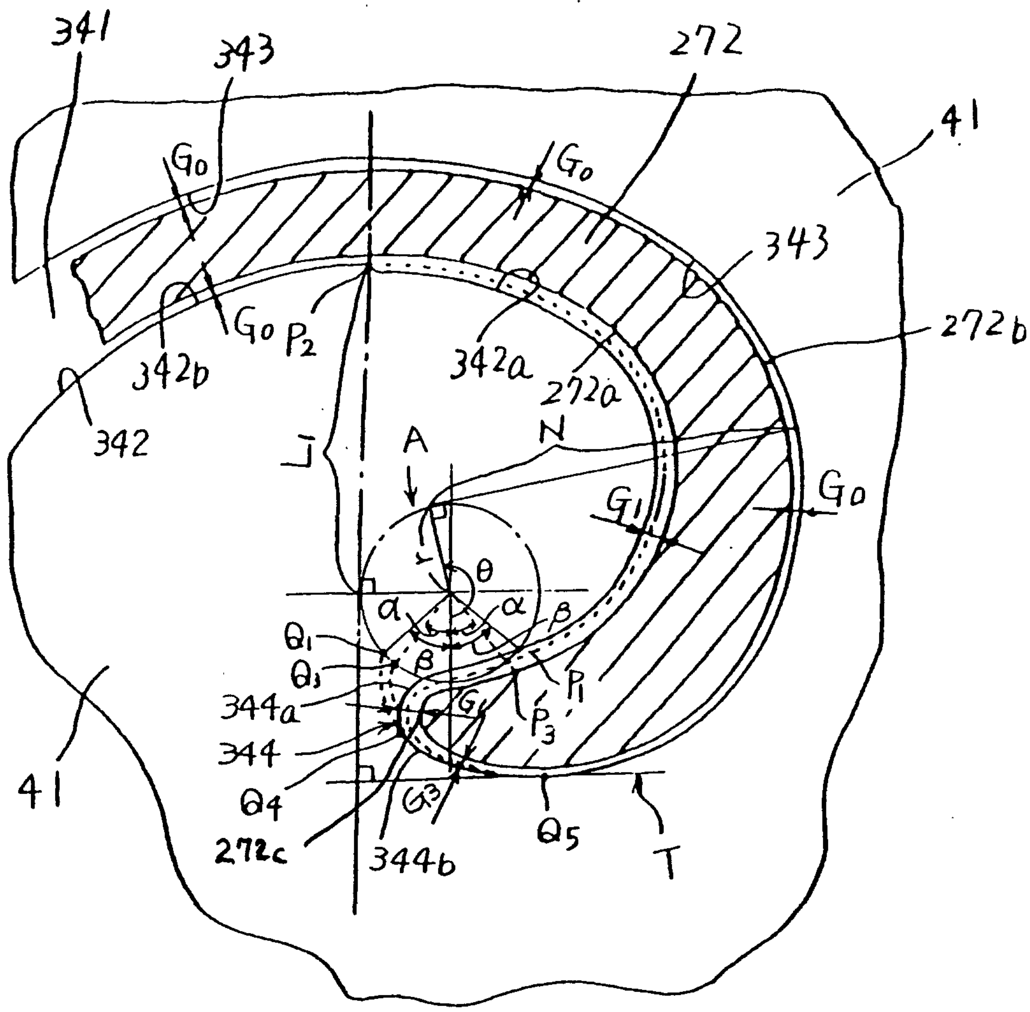

341
343
272
41
G0
G0
343
272b
G0
P2
342b
342a
272a
342
J
A
N
G1
G0
θ
r
α
α
β
Q1
Q3
β
P1
344a
G1
P3
344
Q4
G3
272c
344b
Q5
T
41

FIG. 9

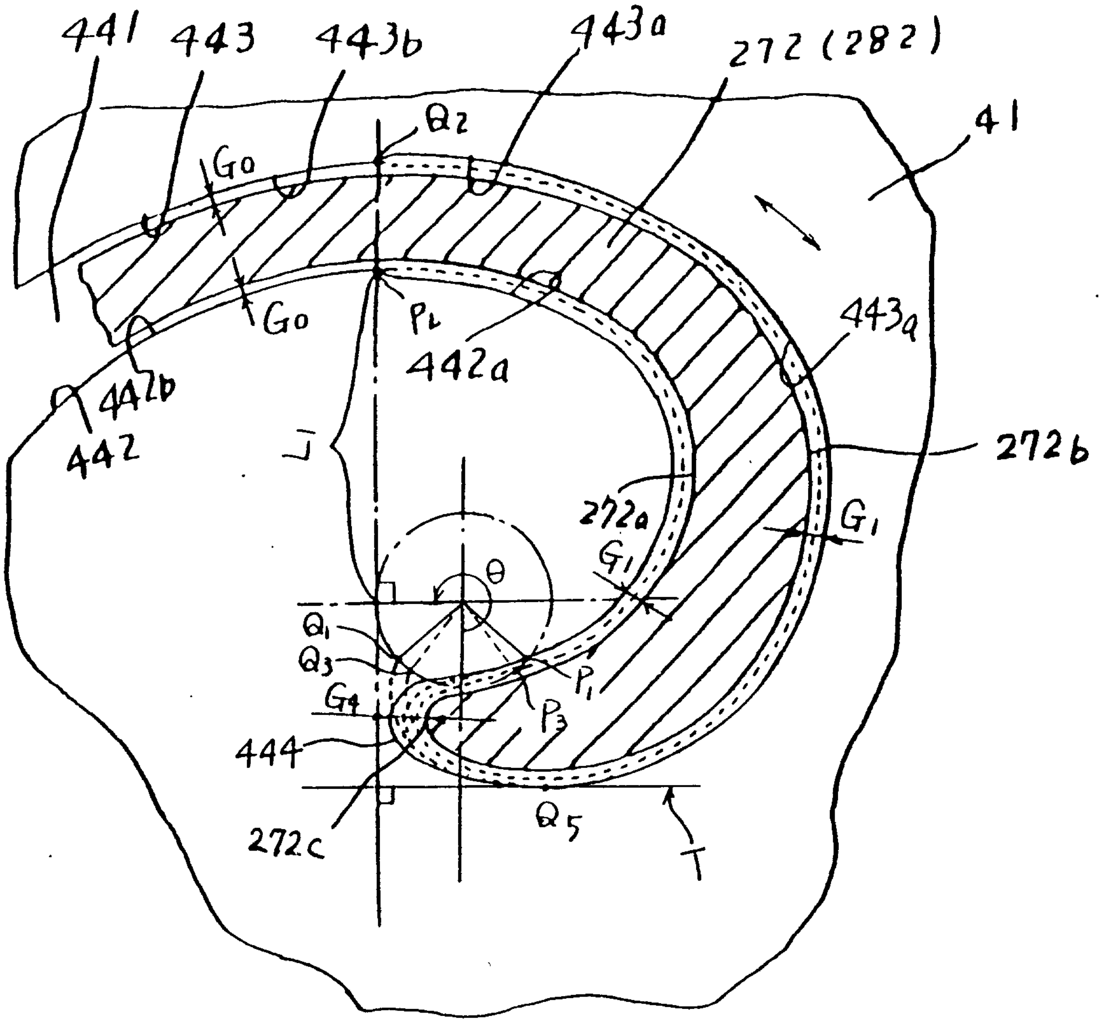

441
443
443b
443a
272 (282)
41
Q2
G0
G0
P2
442a
443a
442b
442
J
272b
272a
G1
G1
θ
Q1
Q3
P1
P3
G4
444
272c
Q5
T

FIG.10

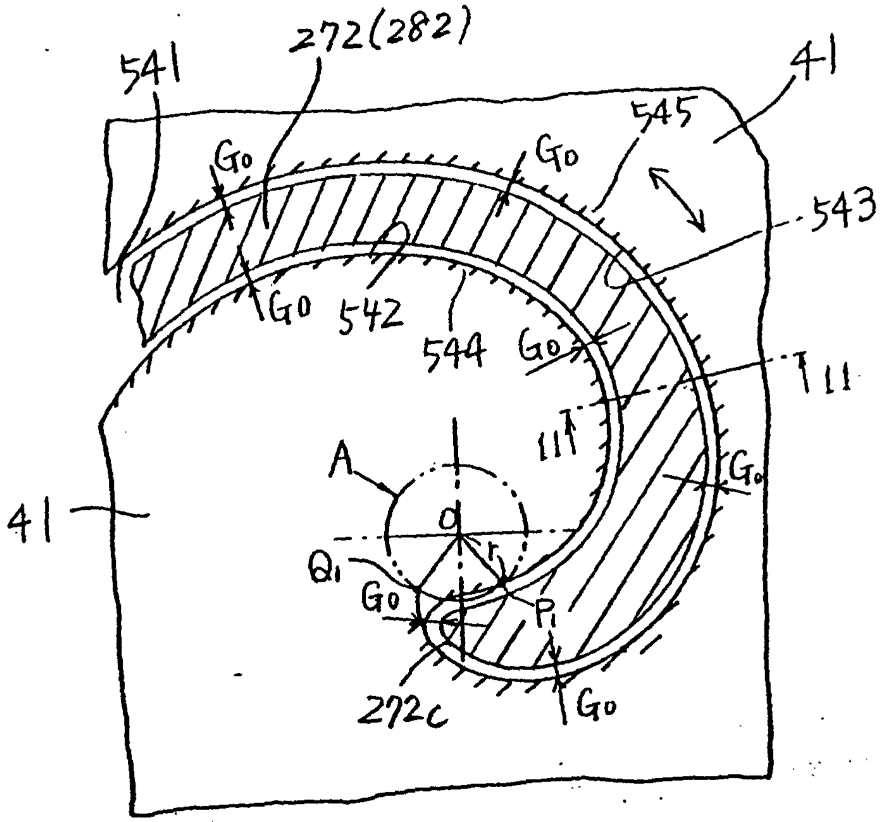
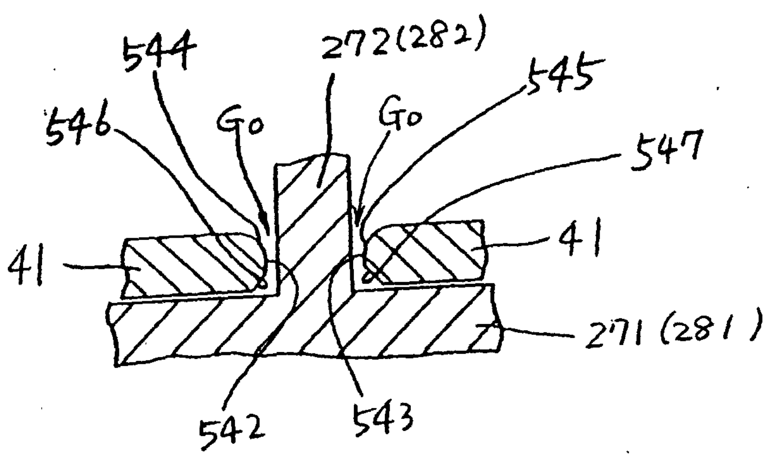

541
272(282)
41
545
G0
543
542
544
11
A
O
r
Q1
P1
272c


FIG.11


544
272(282)
545
546
G0
547
41
271 (281)
542
543